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(54) **ADAPTIVE HEATING SYSTEM WITH EXCHANGEABLE HEAT SOURCES**

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(51) **Int. Cl.**

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H05B 11/00	(2006.01)
F24H 3/04	(2006.01)
F24C 1/04	(2006.01)
F24C 1/16	(2006.01)
F24C 11/00	(2006.01)
F24H 3/02	(2006.01)
F24H 3/12	(2006.01)
F24H 9/20	(2006.01)
H05B 1/02	(2006.01)

(52) **U.S. Cl.**

CPC . ***H05B 11/00*** (2013.01); ***B60L 1/02*** (2013.01); ***F24C 1/04*** (2013.01); ***F24C 1/16*** (2013.01); ***F24C 11/00*** (2013.01); ***F24H 3/025*** (2013.01); ***F24H 3/0429*** (2013.01); ***F24H 3/0441*** (2013.01); ***F24H 3/12*** (2013.01); ***F24H 9/2071*** (2013.01); ***F24H 9/2085*** (2013.01); ***H05B 1/0236*** (2013.01); *H05B 1/028* (2013.01)

(58) **Field of Classification Search**

CPC H05B 1/028

See application file for complete search history.

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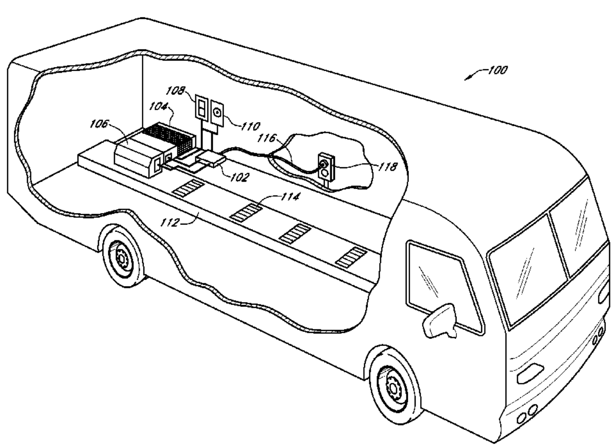
Primary Examiner — Jerome Jackson, Jr.

(57) **ABSTRACT**

An adaptive heating apparatus for heating a recreational vehicle, including a first heat unit configured to be powered by a first energy type, a second heat unit configured to be powered by a second energy type that is different than the first energy type, and a forced-air circulation unit. The adaptive heating apparatus is operable to employ the first heat unit during a first heating operation, or alternatively to employ the second heat unit during a second heating operation. The forced-air circulation unit is configured to circulate air through the both heat units during the first heating operation and to circulate air through both heating units during the second heating operation.

16 Claims, 7 Drawing Sheets



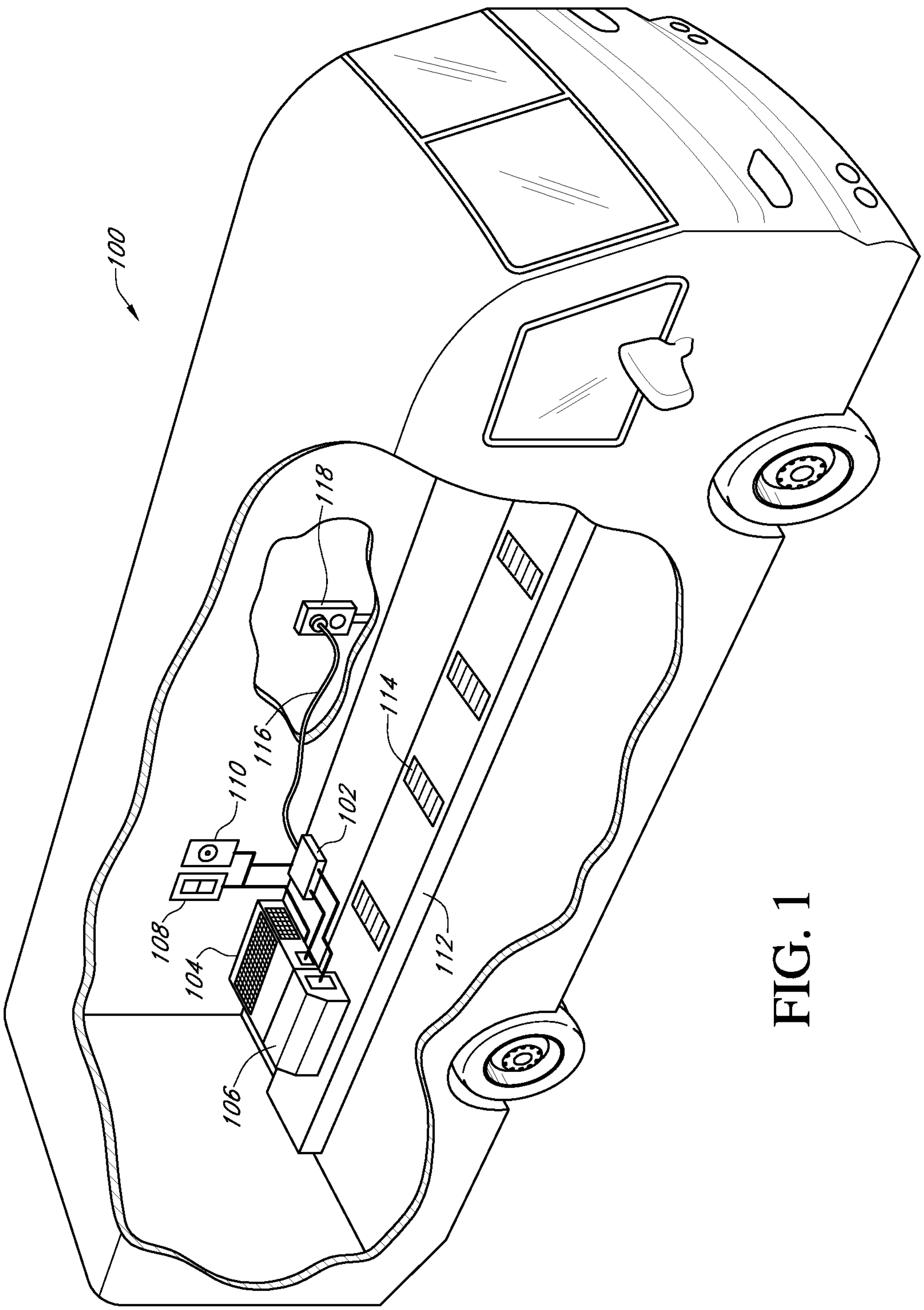


FIG. 1

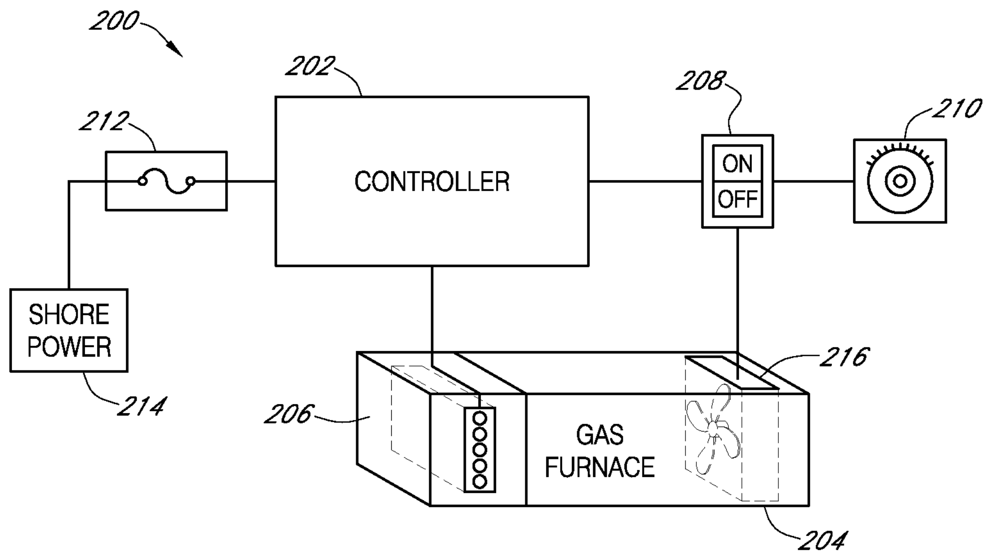

200
202
208
210
212
CONTROLLER
ON
OFF
SHORE POWER
214
216
206
GAS FURNACE
204

FIG. 2A

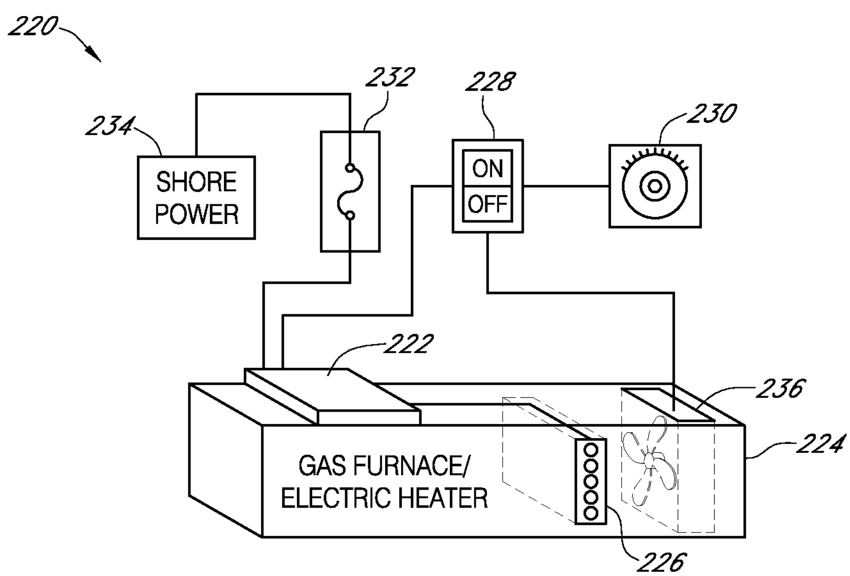
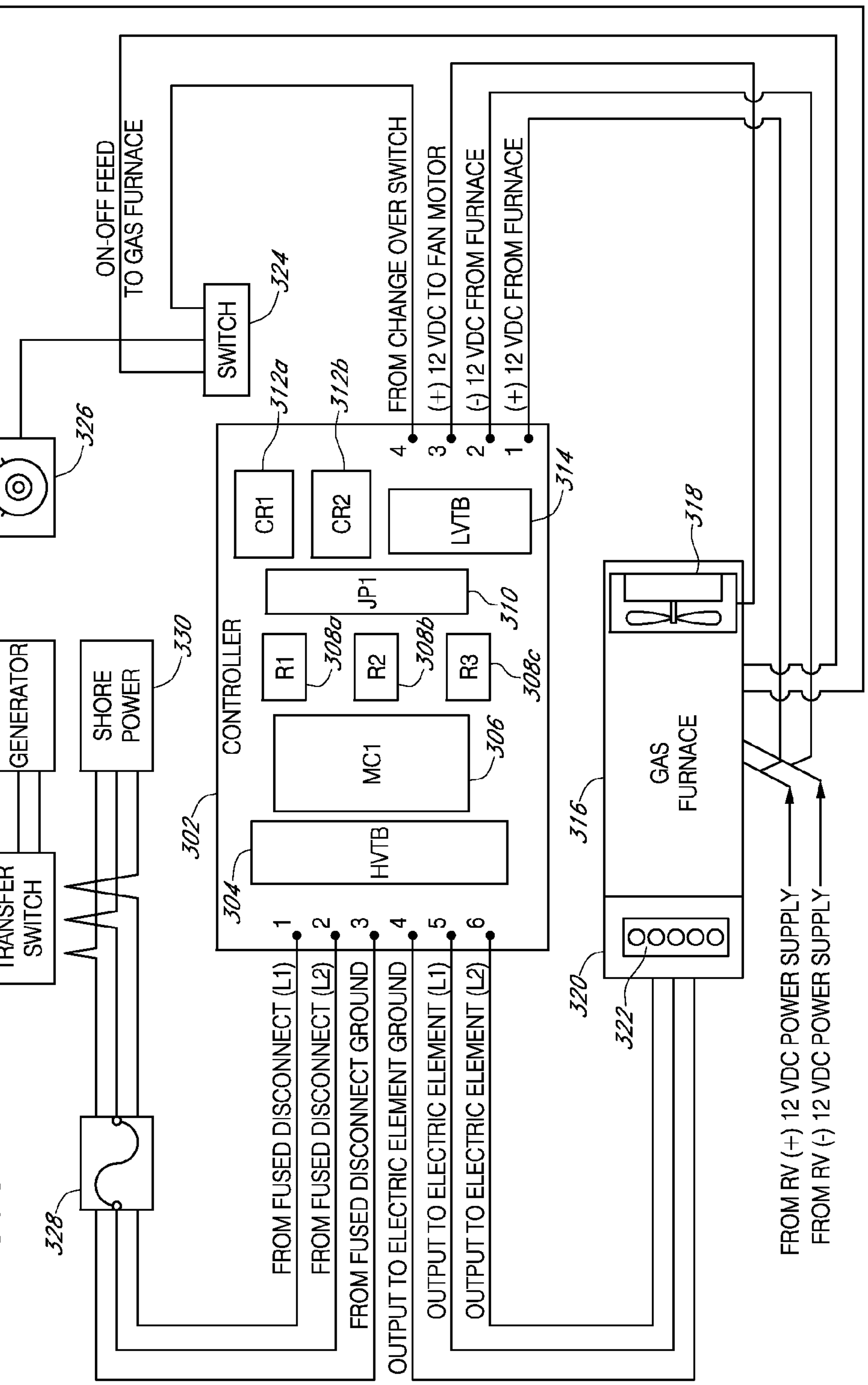

220
232
228
230
234
SHORE POWER
ON
OFF
222
236
224
GAS FURNACE/ ELECTRIC HEATER
226

FIG. 2B

FIG. 3


(+) 12 VDC FEED FROM FURNACE
ON-OFF FEED
TO GAS FURNACE
SWITCH
324
326
FROM CHANGE OVER SWITCH
(+) 12 VDC TO FAN MOTOR
(-) 12 VDC FROM FURNACE
(+) 12 VDC FROM FURNACE
312a
312b
4
3
2
1
CR1
CR2
LVTB
314
318
JP1
310
CONTROLLER
R1
308a
R2
308b
R3
308c
MC1
306
HVTB
304
302
GAS
FURNACE
316
GENERATOR
334
SHORE
POWER
330
TRANSFER
SWITCH
332
328
1
2
3
4
5
6
FROM FUSED DISCONNECT (L1)
FROM FUSED DISCONNECT (L2)
FROM FUSED DISCONNECT GROUND
OUTPUT TO ELECTRIC ELEMENT GROUND
OUTPUT TO ELECTRIC ELEMENT (L1)
OUTPUT TO ELECTRIC ELEMENT (L2)
320
322
FROM RV (+) 12 VDC POWER SUPPLY
FROM RV (-) 12 VDC POWER SUPPLY

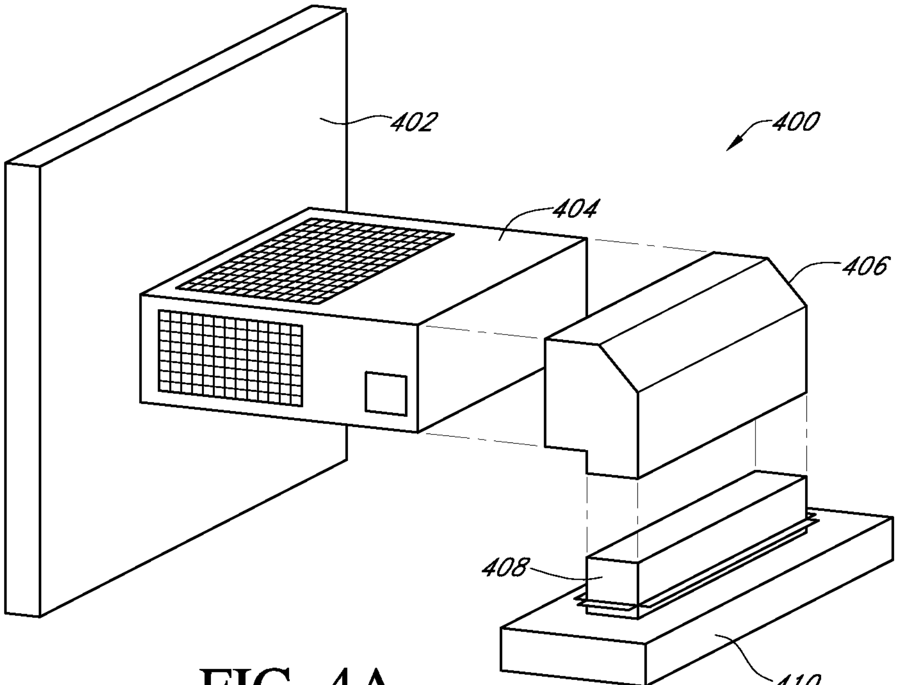


FIG. 4A

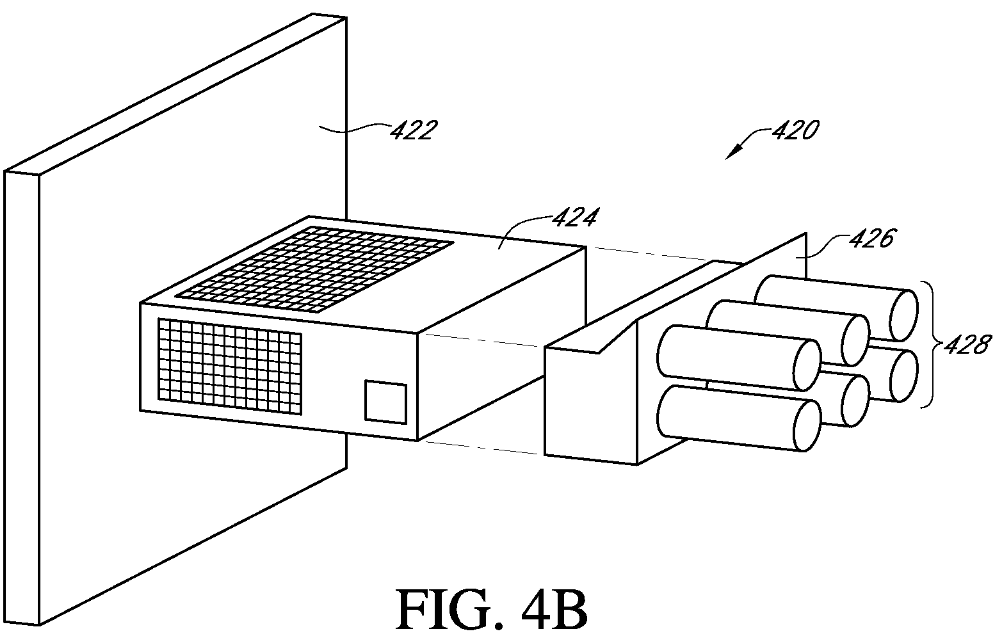


FIG. 4B

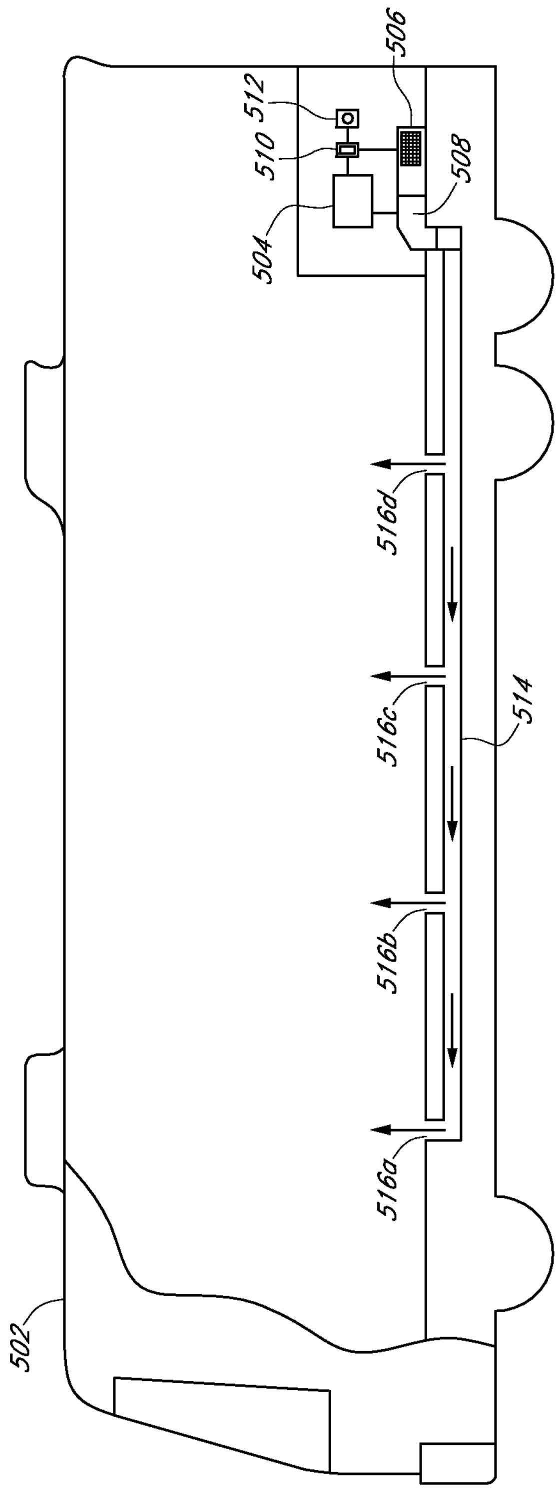


FIG. 5

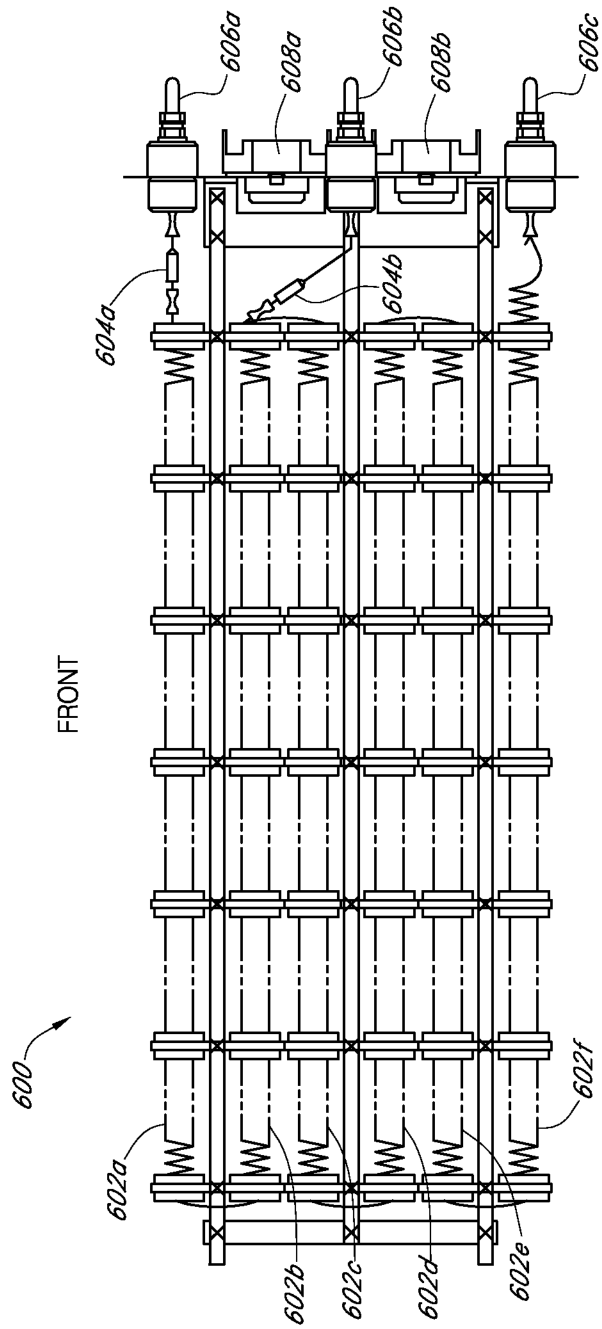

606a
608a
606b
608b
606c
604a
604b
FRONT
600
602a
602b
602c
602d
602e
602f

FIG. 6A

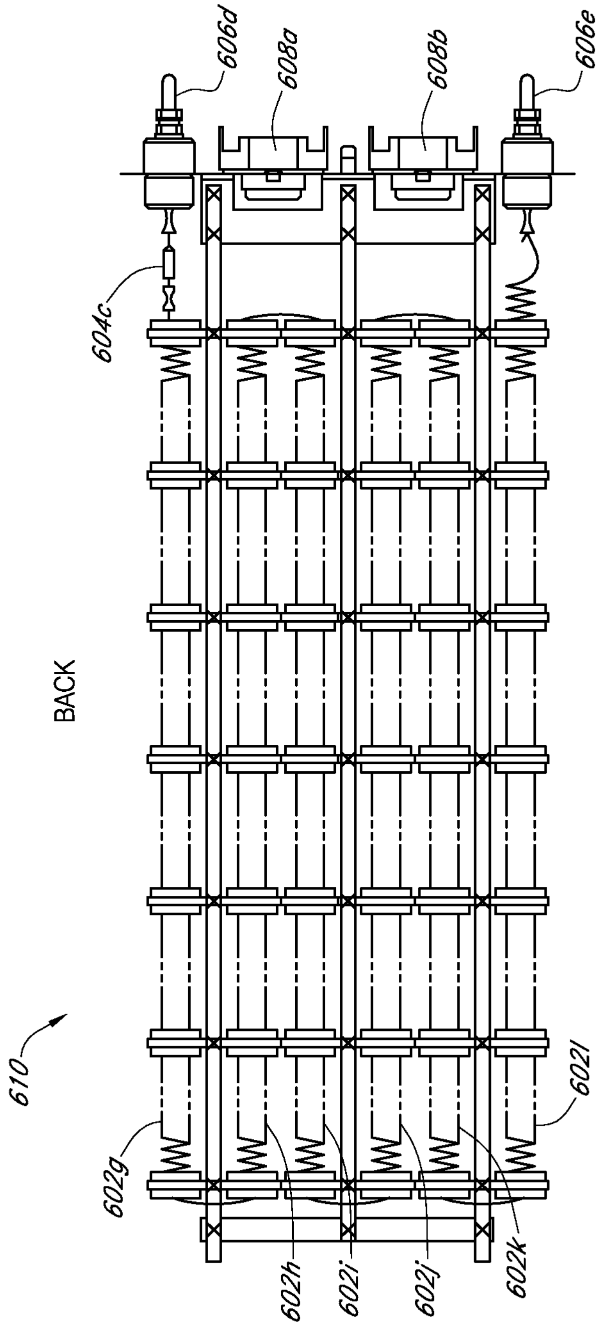

606d
608a
608b
606e
604c
BACK
610
602g
602h
602i
602j
602k
602l

FIG. 6B

ADAPTIVE HEATING SYSTEM WITH EXCHANGEABLE HEAT SOURCES

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of, and claims priority to, commonly owned co-pending U.S. patent application Ser. No. 12/833,005, filed on Jul. 9, 2010 entitled "Systems and Methods for Controlling an Adaptive Heating System with Exchangeable Heat Sources," the entire disclosure of which are incorporated by reference herein in its entirety.

BACKGROUND OF THE INVENTION

At present, the standard for heating a mobile residence, including recreational vehicles, busses, vans, travel trailers, fifth wheelers, mobile homes, aircraft, watercraft, and the like, has been to use liquefied petroleum gas (LPG) as a single, primary heat source. As would be understood by those skilled in the Art, LPG is a flammable mixture of hydrocarbon gases commonly used as a fuel in heating certain appliances (e.g., a gas water heater or a gas stove) and confined areas within a mobile residence. Common varieties of LPG may include mixes that are primarily propane or butane based. These fuel sources can consist of solely butane or solely propane, or more commonly, mixes having both propane (C_3H_8) and butane (C_4H_{10}), depending on the season and the particular vendor of the LPG mix. As would be understood by those skilled in the Art, in the winter months, more propane may be in the mix, and in summer months, more butane may be in the mix.

Although LPG is a low carbon-emitting hydrocarbon fuel that is commonly used to heat mobile residences, there are numerous drawbacks associated with using heat sources operating on this fuel type, as opposed to utilizing other heaters that run on electricity. For example, the cost of LPG is often significantly more expensive than other available heat sources, particularly when an electric power source is readily available as an alternative energy source (e.g., when a shore power source is publically available at an RV park); LPG is flammable and it needs to be properly stored in special tanks that prevent the possibility of a fire or an explosion (i.e., in the event an accident would ignite the LPG within the tank); LPG fuel use results in a toxic carbon monoxide byproduct that can endanger persons residing within a mobile residence if a gas furnace's exhaust fumes were to leak into the confined living area(s) of the mobile residence (e.g., within the cabin of an RV); LPG heating systems require pipes to transfer the gas, and the igniter mechanism of gas furnaces are susceptible to failure due to igniter jets becoming clogged with dust, debris, or spider webs; the tanks this fuel is stored in generally need to be refilled on a semi-regular basis so they do not run out of LPG at inopportune times; and the locations for refueling LPG tanks might not be readily available in certain remote geographic locations where the gas furnaces of mobile residences are routinely utilized.

Further, when using LPG as fuel for a gas furnace that is providing heat to a confined area within a mobile residence, it is not uncommon to have temperatures in that area become too hot or too cold during the operation of the gas heating system. This is so, because furnace based heating and ventilation systems generally operate at very high temperatures and most temperature regulation means (e.g., thermostat devices capable of sensing and adjusting room temperature) often fail to adequately compensate for dramatic temperature changes in a timely manner. Also, because these gas furnace systems run so hot, it generally takes longer for temperatures to cool down in the confined area being heated. This is due to the fact that the heating and ventilation system itself can take a while to cool down.

A corresponding residual heating effect can occur shortly after a gas furnace is turned off, as the system attempts to balance its surface temperatures with a desired room temperature (i.e., the temperature within the confined area of the mobile residence) by radiating retained heat that is essentially remaining thermal energy residing within the metal furnace and ventilation system components and housings. This residual heating effect can negatively impact the temperature control system of a mobile residence and it can also be a source of wasted energy, particularly if a resident air-conditioning system is automatically initiated to combat the unwanted residual heating effects, such as when a preferred temperature, which is lower than a current room temperature, is selected via a resident thermostat device.

Accordingly, although LPG is a viable, relatively clean-burning fuel that is commonly used for heating many mobile residences today, there remains a need to facilitate switching over to a functionally equivalent electric heat source having adequate, distributed heat output capability for a particular mobile residence, whenever feasible. Modern portable electric space heaters generally do not offer adequate, distributed heat output or capacity to properly heat an entire mobile residence. These spot heaters typically have a relatively low power rating and they are not able to be paired with the existing ventilation system of a mobile residence in order to properly facilitate distributing heat to multiple confined areas within a mobile residence or to adequately distribute heat to different portions of the same larger confined area. Further, these portable space heaters can cause a fire hazard when left unattended, due to their feeble construction (e.g., due to their plastic housings and low quality power electronics and wiring) and the fact that they are not configured to be secured within a designated fireproof area or housing within a mobile residence.

Accordingly, it would be beneficial to have improved systems and methods for heating confined areas that could take advantage of a safe efficient electric heat source alternative. It would be desirable if these systems and methods did not solely rely on a single LPG heat source to heat a mobile residence. Further, it would be beneficial if these solutions offered flexibility to the user, such that a user could elect a preferred heat source under varying environmental conditions and in various geographic locations where resource availability might be limited; for example, where a local LPG refill location is not readily available or where an electric power supply is either not present or not accessible. Further, it would also be beneficial to have some levels of automation in these systems, such that heat source selection (between an electric heat source and a gas furnace) could be preprogrammed to facilitate logical automated selection of an appropriate heat source when both gas and electric energy supplies are available. For example, when certain default conditions are detected, heat source selection may be automatically designated by a switch or a controller's onboard logic circuitry (e.g., in an auto-detect mode).

SUMMARY OF THE INVENTION

This summary is provided to introduce (in a simplified form) a selection of concepts that are further described below in the Detailed Description. This summary is not intended to 'identify key features of the claimed subject matter, nor is it intended to be used as an aid in determining the scope of the claimed subject matter.

In overcoming the above disadvantages associated with modern heating systems and methods associated with controlling these heating systems, the present invention discloses an adaptive heating system for optimizing energy resources while heating a confined area. The adaptive heating system includes a controller, a first heat source, a switch device, and a wireline system connecting the controller to the first heat source, a second heat source, and the switch device. In an embodiment, the controller is configured to receive an input from the switch device, determine whether the input indicates a selection of the first heat source or a selection of the second heat source, and initiate operation of either the first or the second heat source, based on the determined selection.

In accordance with one aspect of the present invention, the second heat source is a gas furnace.

In accordance with another aspect of the present invention, the first heat source further includes an electric heating element.

In accordance with a further aspect of the present invention, the first heat source may include a manifold connector facilitating connectivity to a ducted ventilation system.

In accordance with another aspect of the present invention, the first heat source may include a plenum connector facilitating connectivity to a plenum ventilation system.

In accordance with yet another aspect of the present invention, the controller may be connected to a thermostat device that facilitates temperature control for both the first heat source and the second heat source.

In accordance with a further aspect of the present invention, the controller can be connected to the thermostat device via a conductive path comprising the wireline system and the switch device.

In accordance with another aspect of the present invention, the controller may be connected to a shore power source, such that the first heat source can operate using an external power supply that is not a resident component of the adaptive heating system.

In accordance with yet another aspect of the present invention, the controller may be configured to control a heater fan associated with the second heat source in order to circulate air across the electric heating element of the first heat source.

In accordance with a further aspect of the present invention, is an adaptive heating system for installation in a mobile residence. The adaptive heating system includes a controller, an add-on heater cabinet configured to be joined with a resident heat source and a ventilation system of the mobile residence, a switch device, and a wireline system connecting the controller to the add-on heater cabinet, the resident heat source, and the switch device. In an embodiment, the controller is configured to facilitate selection of an electric heater of the add-on heater cabinet or the resident heat source as a preferred heat source, after receiving an input from the switch device.

In accordance with another aspect of the present invention, the mobile residence is a recreational vehicle and the resident heat source is a gas furnace.

In accordance with yet another aspect of the present invention, the add-on heater cabinet includes a specialized connector that facilitates connectivity to the ventilation system of the mobile residence.

In accordance with a further aspect of the present invention, the controller may be configured to be connected with a thermostat device that facilitates temperature control for both the resident heat source and the electric heater.

In accordance with another aspect of the present invention, the controller may be connected to the thermostat device via a conductive path comprising the wireline system and the switch device.

In accordance with yet another aspect of the present invention, the controller may be configured to be connected to a shore power source, peripheral to the mobile residence, such that the electric heater can operate using an external power supply.

In accordance with a further aspect of the present invention, the controller may be configured to control a fan associated with the resident heat source in order to circulate air through the add-on heater cabinet.

In accordance with yet a further aspect of the present invention, the circulated air is heated by the electric heater of the add-on heater cabinet when the controller designates the electric heater to heat the mobile residence, as opposed to the resident heat source.

In accordance with another aspect of the present invention, is a heat source controller for exchanging heat sources utilized to heat the same confined area at different times. The heat source controller includes a high voltage component adapted to receive power from a shore power source and to supply power to an electric heat source, and a low voltage component adapted to receive a heat source selection input and to control operation of a heater fan. The heat source controller may be configured to receive a heat source selection input from a switch device, determine whether the heat source selection input indicates a selection of the electric heat source or a selection of a second heat source, and initiate operation of either the electric heat source or the second heat source, based on the heat source selection input.

In accordance with another aspect of the present invention, the second heat source is a gas furnace.

In accordance with a further aspect of the present invention, the heat source controller may be configured to receive input from a thermostat device that facilitates temperature control for both the electric heat source and the second heat source.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred and alternative examples of the present invention are described in detail below by way of example and with reference to the drawings, in which:

FIG. **1** illustrates a perspective cut-out view depicting an adaptive heating system connected with the ventilation system of a mobile residence, in accordance with an embodiment of the present invention.

FIG. **2**A illustrates a modified block diagram depicting the major components of an adaptive heating system, including an add-on heater cabinet comprising an electric heater, in accordance with an embodiment of the present invention.

FIG. **2**B illustrates a modified block diagram depicting the major components of an adaptive heating system, including a resident electric heater component, in accordance with an embodiment of the present invention.

FIG. **3** illustrates a wireline diagram of an adaptive heating system, associated with the modified block diagram depicted in FIG. **2**A, in accordance with an embodiment of the present invention.

FIG. **4**A illustrates an adaptive heating system with an add-on cabinet that is configured to be connected with a plenum ventilation system, in accordance with an embodiment of the present invention.

FIG. **4**B illustrates an adaptive heating system with an add-on cabinet that is configured to be connected with a ducted ventilation system, in accordance with an embodiment of the present invention.

FIG. **5** illustrates an air-flow diagram that depicts the source and flow of heated air throughout the confined areas of a mobile residence, in accordance with an embodiment of the present invention.

FIG. **6**A illustrates the front side view of an electric heater element capable of operating at multiple power output levels, in accordance with an embodiment of the present invention.

FIG. **6**B illustrates the back side view of the electric heater element of FIG. **6**A, capable of operating at multiple power output levels, in accordance with an embodiment of the present invention.

DETAILED DESCRIPTION

In accordance with an exemplary embodiment of the present invention, FIG. **1** illustrates an adaptive heating system connected to the ventilation system of a mobile residence **100**. It should be understood that the term "mobile residence" is not limited only to recreational vehicles, as depicted in FIG. **1**. Instead, the term mobile residence should be interpreted to include busses, vans, travel trailers, fifth wheelers, mobile homes, aircraft, watercraft, and the like. Any of these mobile residences may be adapted to comprise any of the heating systems and implement any of the methods associated with the present invention. In an embodiment, the mobile residence **100** includes an existing ventilation system **112** having a number of ventilation registers **114** distributed throughout the confined/enclosed area(s) of the mobile residence **100**. As used herein, the term "register" generally refers to an adjustable, grill-like device through which heated or conditioned air may be released into a confined area.

As would be understood by those skilled in the Art, ventilation systems in various mobile residences **100** may be different in hardware implementation (e.g., some systems may be plenum based ventilation systems, ducted ventilation systems, or any combination thereof) and ventilation topology (e.g., having various ventilation runs servicing confined areas that are distributed within a particular mobile residence **100**). This is so, because the confined area(s) within mobile residences **100** often vary in size, layout, physical obstruction(s), wall insulation quality, etc. Accordingly, it is important to have an adaptive heating system that is truly universal, such that it can be readily added to, or built in to, any mobile residence's **100** heating and ventilation system **112**. The systems and methods of the present invention facilitate this functionality by being designed and implemented in such a way as to be compatible with most mobile residence heating and ventilation systems on the market today.

In an embodiment, the primary components of the adaptive heating system depicted in FIG. **1**, include, but are not limited to, at least the following components: a controller **102** (also interchangeably referred to herein as: "a heat source controller"), an electric heat source **106**, a switch device **108**, a resident gas furnace **104**, and a resident thermostat device **110**. In an embodiment, the controller **102**, the electric heat source **106** (e.g., a specialized add-on heater cabinet having an electric heating element embodied therein; See e.g., FIGS. **6**A-B), and the switch device **108**, may each be added to an existing heating and ventilation system (e.g., a system including a gas furnace **104**, a ventilation system **112**, and a thermostat device **110**) of a mobile residence **100** by:

1. Configuring/installing the add-on electric heat source **106** to be connected with the both the gas furnace **104** and the ventilation system **112** (e.g., as depicted in FIG. **1** and FIG. **4**A);

2. Configuring/installing the switch device **108** to be electrically connected with the thermostat device **110** via a wireline system (See e.g., the wireline systems depicted in FIG. **2**A and FIG. **3**); and

3. Configuring/installing the controller **102** to be electrically connected to each of the electric heat source **106** (e.g., the add-on heater cabinet), the gas furnace **104**, the switch device **108**, and the thermostat device **110** (e.g., indirectly using the switch device as a bypass), via the wireline system (See e.g., the wireline systems depicted in FIG. **2**A and FIG. **3**).

In another embodiment, the controller **102** and/or the electric heat source **106** may be incorporated into a single heater unit that also includes the gas furnace **104** (See e.g., the adaptive heating system **220** of FIG. **2**B). In this embodiment, the single hybrid heater unit (not shown in FIG. **1**) and the switch device **108** may be part of an existing adaptive heating and ventilation system (e.g., including the ventilation system **112**, the switch device **108**, and the thermostat device **110**) of a mobile residence **100**.

Whether the adaptive heating system of the present invention is an add-on, aftermarket system or part of an integrated, manufacturer-side system, both system configurations may be employed within a mobile residence **100** to achieve substantially similar results. These results include the functionality of allowing for preferred selection of an optimal heat source (e.g., either the electric heat source **106** or the gas furnace heat source **104**), when an energy supply is available for each heat source (e.g., availability of a local shore power supply **118**, also interchangeably referred to as an "external power supply", and a tank storing an adequate supply of LPG).

In FIG. **1**, the LPG tank (not shown) may be co-located near the gas furnace **104** and the electric heat source **106** may be supplied power, indirectly, via the controller **102**, which itself may be connected to an external power supply **118** (e.g., a shore power source **118** peripheral to the mobile residence **100**) via an electrical power cord **116** that can extend outside of the mobile residence **100**. Generally there would be a breaker or fuse device (not shown in FIG. **1**) between the external power supply **118** and the controller **102**, as discussed further herein. In an embodiment, when both gas and electrical energy resources are available, a user can manually flip the switch device **108** to select either one of the gas furnace **104** or the electric heat source **106** as the operational heat source for the mobile residence **100**, at any particular time. In this way, a user can readily exchange heat sources based on either preference or necessity.

In accordance with another embodiment of the present invention, the switch device **108** may be an automatic or a hybrid manual/automatic switch device (not shown) that is capable of instructing the controller **102** to select the electric heat source **106** over the gas furnace **104**, whenever connection to an external power supply **118** is detected (or vice-versa whenever an external power supply **118** is disconnected). In other embodiments, it is envisioned that an automatic or a hybrid switch device may detect some other predefined condition and then automatically issue an instruction to the controller **102** to switch over to one of the electric heat source **106** or the gas furnace **104**, depending on whether or not a condition threshold was reached or exceeded.

For example, a condition threshold may be related to a level of remaining LPG in the LGP tank on board the mobile residence **100**. In a scenario where the LPG level drops below a predefined LPG threshold (this may be detectable by a sensor connected with the LPG tank), the automatic or hybrid switch device may automatically instruct the controller **102** to switch over to the electric heat source **106**. In another scenario, the automatic or hybrid switch device may only inform the controller **102** that the condition threshold has been reached or exceeded. In this scenario, the controller **102** may itself determine to automatically switch over to the electric heat source **106** or the gas furnace **104** after receiving only an indication that a condition threshold was reached or exceeded (e.g., an indication of whether or not an electric power supply **118** is presently available). Other conditional thresholds that may initiate an automatic switch between heat sources **104** and **106** may relate to a temperature level within a confined area, a surface temperature associated with the surface of any of heating and ventilation system components, an outside temperature, or any other common condition that may influence or necessitate a change between the gas furnace **104** and the electric heat source **106** as a primary heat source.

FIG. **2**A illustrates a modified block diagram **200** depicting the major components of an adaptive heating system **200**, including an add-on heater cabinet **206** comprising an electric heating element, in accordance with an embodiment of the present invention. It should be understood that the adaptive heating system **200** is a simplified block diagram showing connectivity only between major system components. Other connections and system components could be added to the heating system **200** without departing from the spirit and scope of the present invention. In an embodiment, the adaptive heating system **200** includes at least the following components: a controller **202**; a gas furnace **204** having an internal fan **216** for circulating air through the gas furnace **204**; an electric heat source **206** that may be an add-on heater cabinet comprising and electric heating element (See e.g., FIGS. **6**A-B); a switch device **208** that facilitates selection of either the electric heat source **206** or the gas furnace **204** as a preferred heat source; a thermostat device **210** that can be utilized by the controller **202** to control the heat output levels for either the electric heat source **206** or the gas furnace **204**, depending on a heat source selection; a shore power source **214** that can provide electric power to the controller **202**, which in turn provides power to the electric heat source **206**, when the electric heat source **206** is in use; and a breaker or fuse device **212** that facilitates quick disconnection of the high voltage link between the shore power source **214** and the controller **202** in the event of a power surge and/or in the event an unusually high operating temperature is realized at the breaker or fuse device **212**.

In operation, when a heat source selection has been made at or by the switch device **208** (e.g., via manual or an automatic selection), the controller **202** turns OFF one heat source (e.g., the gas furnace **204**) and subsequently turns ON the other heat source (e.g., the electric heat source **206**). The controller **202** may allow/facilitate the fan **204** operating at one of multiple available fan speeds. In an embodiment, these alternate fan speeds may be selected in order to circulate air more rapidly throughout a mobile residence **100** and/or in order to distribute heated air more efficiently throughout the confined area(s) of a mobile residence **100**. In an embodiment, the controller **202** may receive input from the thermostat device **210** that allows it to make determinations as to what level of heat output may be required from a controlled heat source (e.g., an electric heat source **206**). In an embodiment, the thermostat device **210** may control the gas furnace **204** directly via an internal circuit board at the gas furnace **204**, while the controller **202** may use input from the thermostat device **210** to control the electric heat source **206**.

FIG. **2**B illustrates a modified block diagram depicting the major components of an adaptive heating system **220**, including a resident electric heating element **226** therein, in accordance with an embodiment of the present invention. It should be understood that the adaptive heating system **220** is a simplified block diagram showing connectivity only between major system components. Other connections and system components could be added to the heating system **220** without departing from the spirit and scope of the present invention. In an embodiment, the adaptive heating system **220** includes at least the following components: a combined gas furnace/electric heat source unit **224** that has an internal fan **236** for circulating air through the gas furnace and across an resident electric heating element **226** that is part of the combined heat source unit **224**; a controller **222** that is joined with the combined gas furnace/electric heat source unit **224**, a switch device **228** that facilitates selection (this selection may be automatic or manual) of either the resident electric heating element **226** or the gas furnace component of the combined heat source unit **224** as a preferred heat source; a thermostat device **230** that can provide input to the controller **222** (e.g., indirectly via the switch device **228**) to facilitate management of the heat output levels for either the electric heating element **226** or the gas furnace of the combined heat source unit **224** (depending on a heat source selection); a shore power source **234** (e.g., an external power supply) that can provide electric power to the controller **222**, which can in turn provide power to the electric heating element **226**, when in use; and a breaker or fuse device **232** that facilitates quick disconnection of the high voltage link between the shore power source **234** and the controller **222** in the event of a power surge and/or an unusually high operating temperature.

Similar to the operation of the adaptive heating system of FIG. **2**A, when a heat source selection has been made at or by the switch device **228** (e.g., by a manual, an automatic, or a hybrid switch selection), the controller **222** turns OFF one heat source (e.g., the gas furnace) and subsequently turns ON the other heat source (e.g., the electric heating element **226**). When operation of the electric heating element **226** is selected, the controller **222** can facilitate the fan's **236** operation at one of multiple available fan speeds. In an embodiment, the controller **222** may receive input from the thermostat device **230** that facilitates the controller's **222** determinations as to what level of heat output may be required from either heat source.

It should be understood that in both FIG. **2**A and FIG. **2**B, the respective heater fans **204** and **236** are capable of circulating air through the electric and the gas heat sources **206**, **226**, **204** and **224**, while at the same time circulating air through a resident ventilation system (e.g., **112** of FIG. **1**) of a particular mobile residence (e.g., **100** of FIG. **1**).

FIG. **3** illustrates a wireline diagram of an adaptive heating system, associated with the block diagram depicted in FIG. **2**A, in accordance with an embodiment of the present invention. In an embodiment, the adaptive heating system includes at least the following major components: a controller **302**; a gas furnace **316** with a heater fan **318**; an electric heat source **320** with an electric heating element **322** (See e.g., FIGS. **6**A-B); a switch device **324**; a thermostat device **326**; a shore power source **330**; a breaker or fuse device **328**; a transfer switch **332**; and an auxiliary generator **334**. As would be understood by those skilled in the art, the adaptive heating system depicted in FIG. **3** may operate in an electrical heat source mode, by utilizing and electrical power supply emanating from either a shore power source **330** or an auxiliary generator **334**. In an embodiment, the transfer switch **332** may facilitate an electrical power source selection.

In an embodiment the adaptive heating system's components may be described as follows: the gas furnace **316** may be an existing component of the adaptive heating system (e.g., a part of a mobile residence's **100** existing heating and ventilation system). The furnace may be an optional heat source for a forced air heating system associated with the present invention. A couple well known manufacturers of gas furnaces for mobile residences are Atwood™ and Suburban Manufacturing™; the electric heat source **320** with an electric heater element **322** may also be referred to interchangeably herein as an "electric heater." The electric heater may be a added on to an existing gas furnace (See e.g., FIG. **2**A) or it may be built directly into a gas furnace at the factory (See e.g., FIG. **2**B), in any number of positional configurations, without departing from the spirit and scope of the present invention; the switch device **324** may be a manual single pole double throw (SPDT) ON/ON switch, an automatic switch, or a hybrid switch (discussed supra), that is used to switch the output from the thermostat **326**, between the controller **302** and the gas furnace **316**. The switch can be utilized to turn either heat source **322** or **316** ON or OFF utilizing the controller **302** (depending on a current operating state); the thermostat device **326** may be a preexisting device in a mobile residence's **100** heating and ventilation system, which can be used to automatically control the temperature in a confined area by turning the heating system and/or an auxiliary air-conditioning system ON or OFF, in response to a heat source selection input; the shore power source **338** is an electrical power supply that may be available to a mobile residence **100** by an electric utility provider; the breaker or fuse device **328** is a disconnect that may be a current limiting device that is installed between a power source (e.g., the shore power **330** or the generator **334**) and the controller **302**, in order to protect the high voltage wiring in the presence of an overload condition, such as a power surge; and the transfer switch **332** is an optional component that may be used to switch the power source of a mobile residence **100** between a shore power source **330** and an auxiliary generator **334**. The generator **334** is a backup power source that is not generally used to supply power to the adaptive heating system of the present invention.

In an embodiment, the controller **302** includes at least the following components: a high-voltage terminal block **304** (HVTB); a high voltage contactor **306** (MC**1**); three resistive loads **308***a-c* (R**1**, R**2**, and R**3**); a jumper component **310** (JP**1**); two relays **312***a-b* (CR**1** andCR**2**); and a low-voltage terminal block **314** (LVTB).

The controller **302**, will be defined by the function of its components, as follows: the high-voltage terminal block **304** (HVTB) acts as the point of connection for the 120/240 VAC wiring and components that are attached to the controller, as depicted in FIG. **3**; the high voltage contactor **306** (MC**1**) may be a high voltage, 30 amp, normally open (NO) double pole single throw (DPST) contactor used to turn power ON or OFF for the electric heating element **322**. MC**1 306** is controlled by CR**2 312***b*, which is itself controlled by input from the thermostat device **326** when the switch device **324** is in the electric heater position (12 VDC coil, 30 amp, 120/240 volt contacts); the resistive loads **308***a-c* (R**1**, R**2**, and R**3**) are used in various combinations to reduce the voltage of the fan **318** via the jumper component(s) **310**; the jumper component(s) **310** (JP**1**) may be used to control the speed of the fan **318** in the gas furnace when the switch device **324** is in the electric heater position. In an embodiment, there are multiple jumpers included in JP**1 310** that allow power to flow through one or all the resistive loads R**1**, R**2**, and R**3 308***a-c* to achieve a desired fan speed during operation of the electric heater **322**; the first relay **312***a* (CR**1**) is a normally open (NO) single pole single throw (SPST) relay used to turn the furnace fan **318** ON or OFF. CR**1** is controlled by the thermostat device **326** when the switch device **324** is in the electric heater mode (12VDC coil, 20 amp, 12VDC contacts); the second relay **312***b* (CR**2**) is a normally open (NO) single pole single throw (SPST) relay, which is used to isolate the 12VDC from the 120/240 VAC, and to turn MC**1 306** ON or OFF. CR**2 312***b* is controlled by the thermostat device **326** when the switch device **324** is in the electric heater mode (12VDC coil, 5 amp, 12VDC contacts); and the low-voltage terminal block **314** (LVTB) acts as the point of connection for 12 VDC wiring and components that are attached to the controller **302**, as depicted in FIG. **3**.

In an embodiment, the wiring depicted in FIG. **3** may be collectively referred to herein as a "wireline system." This wireline system includes both a high voltage AC component emanating from the shore power source **330** or the generator **334**, connecting with the HVTB **304**, and emanating from the HVTB **304** to the electric heat source **320**, comprising the electric heating element **322**. The wireline system also includes a low voltage DC component emanating from a mobile residence's (e.g., **100** of FIG. **1**) 12VDC power supply, connecting with the gas furnace **316**, and emanating from the furnace to the LVTB **314**. The high voltage AC and low voltage DC components of the wireline system are labeled in FIG. **3** to facilitate easier understanding by those skilled in the Art.

FIG. **4**A illustrates an adaptive heating system **400** with an add-on heater cabinet **406** that is configured to be connected with a plenum ventilation system **410**. In an embodiment of the present invention, a gas furnace **404** for a mobile residence (e.g., **100** of FIG. **1**) is shown connected to a wall **402** of the mobile residence. The gas furnace **404** includes exterior ventilation (not shown) that allows the furnace to expel gas combustion byproducts to the exterior of the mobile residence, when the furnace is in operation. The furnace **404** also includes interior intake ventilation (depicted as the vent grills on the sides and top of the furnace) that allows the furnace to take in oxygen-rich air to facilitate the gas combustion, while heating a confined area of a mobile residence.

In an embodiment, the add-on heater cabinet **406** may be joined with the heated air output side of the gas furnace **404** (the side where the furnace's fan expels heated air), as well as the plenum based ventilation system **410**, by a plenum ventilation connector **408** that securely joins the add-on cabinet **406** to the existing ventilation system **410** of a mobile residence (e.g., **100** of FIG. **1**). In this configuration, air heated by the gas furnace **404** is circulated from the furnace **404**, through the add-on heater cabinet **406** (comprising an electric heating element) and the plenum based ventilation system **410** that includes multiple ventilation registers (not shown).

FIG. **4**B illustrates an adaptive heating system **420** with an add-on cabinet **424** that is configured to be connected with a ducted ventilation system **428**. In an embodiment of the present invention, a gas furnace **424** is shown connected to the wall **422** of a mobile residence **100**. The gas furnace **424** includes exterior ventilation (not shown), and interior intake ventilation (depicted as the vent grills on the sides and top of the furnace).

In an embodiment, the add-on heater cabinet **426** may be joined with the heated air output side of the gas furnace **424** (the side where the furnace's fan expels heated air), as well as the ducted ventilation system **428** of a mobile residence (e.g., **100** of FIG. **1**), via a manifold ventilation connector of the add-on heater cabinet (not shown). In this configuration, air heated by the gas furnace **424** can be circulated from the furnace **424**, through the heater cabinet **426** (comprising an electric heating element) and the ducted based ventilation system **428** that includes multiple ventilation registers (not shown).

FIG. **5** illustrates an air-flow diagram that depicts the source and flow of heated air throughout the confined areas of a mobile residence **502**. In an embodiment, an inhabitant of the mobile residence **502** may selects either a gas furnace **506** or an electric heat source **508** as a preferred heat source, utilizing a switch device **510** that may be mounted on an interior wall of the mobile residence **502**. Alternately, the switch device **510** may be an automatic or a hybrid switch device (discussed supra). It is contemplated within the scope of the present invention that the switch device could be part of the controller **504** or part of a single hybrid heater unit (e.g., a gas/electric heater unit with an onboard controller). This consolidated design would be particularly practical where the switch device **510** was an automatic switch having logic circuitry that facilitates heat source selections, in accordance with various detected system conditions (discussed supra), as opposed to a manual switch that requires user input.

Whether the electric heat source **508** or the gas furnace **506** was selected as a preferred heat source, the designated temperature set at the thermostat device **512** would facilitate determinations as to what level of heat would need to be output by the selected heat source and/or for how long the designated heat source should operate. In the electric heat source mode, the controller **504** would be capable of adjusting the heater fan (not shown) within the gas furnace **506** and the operating power of the electric heater element within the electric heat source **508**, in order to output the right amount of heat and air flow to efficiently adjust the temperature within the confined area(s) of the mobile residence **502**, until a stable, desired room temperature was achieved.

In an embodiment, the fan within the gas furnace **506** would be capable of forcing air through the activated gas furnace **506** or through the activated electric heat source **504** at a rate sufficient to properly heat the air inside the operating heat source before circulating the heated air through the backbone of the ventilation system **514** (e.g., a plenum or a ducted ventilation backbone) and out into the confined living areas of the mobile residence **502** via any number of distributed ventilation ducts and/or ventilation registers **516***a-d*. Generally, when the air temperature within the confined area(s) of the mobile residence achieved a temperature associated with a set room temperature of the thermostat device **512**, the selected operating heat source would be powered down (partially or completely) to reduce a heat source output to a stable temperature.

FIG. **6**A illustrates the front side view of an electric heater element **600** capable of operating at multiple power output levels, which facilitates the output of multiple levels of heat. FIG. **6**B illustrates the back side view of an electric heater element **610** that is the same heater element depicted in the front side view **600** of FIG. **6**A. In an embodiment, the heater element **600** and **610** of FIGS. **6**A-B is capable of operating at a total of 7 different heating power outputs.

These variable electric heater element outputs are listed in Table 1 below:

TABLE 1

High Voltage AC Electric Heater Input	Electric Heater Output Watts/BTU's
120 VAC	684 Watts/2335 BTU's per hour
120 VAC	762 Watts/2603 BTU's per hour
120 VAC	937 Watts/3200 BTU's per hour
120 VAC	1250 Watts/4267 BTU's per hour
120 VAC	1800 Watts/6145 BTU's per hour
240 VAC	3750 Watts/12800 BTU's per hour
240 VAC	5000 Watts/17070 BTU's per hour

It should be understood that the electric heater element **600** and **610**, depicted in FIGS. **6**A-B, could be configured to operate at other variable power/heat outputs (e.g., at other Electric Heater Output ratings than those listed in Table 1), without departing from the spirit and scope of the present invention.

In an embodiment, the electric heater element **600** and **610** includes at least the following components: multiple heater coils **602***a*-**1**, multiple fusible links **604***a-c*, multiple power terminals **606***a-e*, and multiple insulator terminals **608***a-b*. The electric heater element **600** and **610** will be defined by the function of its primary components. The heater coils **602***a*-**1** may be open wire coils (e.g., composed of a ⅜ inch diameter coil) that are made of a wire type (e.g., Nicrome wire) with specific resistance ratings (measured in Ohms) to facilitate a variable heat/thermal power output. In an embodiment, different sets of the wire coils **602***a*-**1** may be configured to facilitate the heater element **600** and **610** having different heat outputs. For example, a first set of coils may have 8 Ohms of resistance that can produce a heat output of 6145 BTUs per hour (on the 120 VAC side), while a second set of coils may have 11.3 Ohms of resistance that can produce a heat output of 17070 BTUs per hour (on the 240 VAC side). A third set of coils may have 3.8 Ohms of resistance, and when placed in series with the 11.3 Ohm set of coils, the combined coils can produce a heat output of 12803 BTUs per hour (on the 240 VAC side). As noted in Table 1, the associated power outputs facilitated by these particular combinations would be 1800 Watts (associated with the heat output of 6145 BTU's per hour), 3750 Watts (associated with the heat output of 12800 BTU's per hour), and 5000 Watts (associated with the heat output of 17070 BTU's per hour).

The multiple fusible links **604***a-c*, are failsafe devices that are designed to melt at a particular operating temperature (e.g., 350 degrees Fahrenheit) to stop the flow of current to the electric heater element's **600** and **610** components (e.g., the heater coils **602***a*-**1**) when too hot of an operating temperature could result in a fire hazard. The multiple power terminals **606***a-e* are adapted to be connected with an external electrical power supply (e.g., a high voltage power supply coming from a controller device **302** and emanating from a shore power source **330**) and they are configured to facilitate a particular output power when various combinations of the multiple heater coils **602***a*-**1** are used to heat a confined area. In one embodiment, the power output of the heater element **600** and **610** would be 3750 Watts when terminals **606***a* and **606***c* were connected to a 240 VAC power supply. In an embodiment, the power output of the heater element **600** and **610** would be 5000 Watts when terminals **606***b* and **606***c* were connected to a 240 VAC power supply. In an embodiment, the power output of the heater element **600** and **610** would be 1800 Watts when terminals **606***d* and **606***e* were connected to a 120 VAC power supply. The multiple insulator terminals **608***a-b* (e.g., porcelain insulator terminals) are high temperature electric insulators that may be used to support the high voltage power input's connection with the multiple heater coils **602***a-l*. It should be understood that the above listing of electric heater element **600** and **610** components is not a complete listing of parts for the electric heater element. As would be understood by those skilled in the Art, only primary components of the heater element have been described herein. Accordingly, there may be other component parts to the heater element that support/facilitate its functionality.

Returning to the FIGS. **2**A and **2**B, the thermostat **230** (of FIG. **2**B) may be located either internally to the heating system or external to it. The thermostat may be located internally (that is, inside the first heating stage) in certain preinstalled heating systems found in recreational vehicles. The advantage of using a thermostat located internally is that it is already installed as part of the heating system and does not require additional installation or wiring outside of that already necessary for installation of the remainder of the heating system. The internally located thermostat may not give as reliable results as a thermostat located externally to the heating system. While the external thermostat may be more expensive to install because it will require additional wiring, it may give more accurate (and lead to more comfortable results) because it directly measures the temperature of the air in the living space of the recreational vehicle. Either way, the thermostat may control one or both stages of the modified heating system, such as the one found in FIG. **2**B. In an embodiment of the present invention, the thermostat **230** may operate the two heating sources simultaneously. It may adjust the output of each heating stage to achieve some optimal result. For instance, it may adjust the outputs of the heating stage so that each stage runs in its most efficient zone. This may be to save money on fuel and/or electricity or to improve (that is, lessen) the environmental impact of the recreational vehicle. In some instances, the thermostat **230** may direct both heating stages to run on full to heat the recreational vehicle as quickly as possible. In an embodiment, the thermostat **230** or the switch device **228** may have logic that it capable of assessing at what level each stage needs to run to satisfy the setting of the thermostat. The thermostat **230**, regardless of whether it is installed internally to the heating stages or external to them, may be run in either automatic or manual mode. In an embodiment of the present, automatic is different from manual in that is as an automated non-manual adjustment used to regulate or change. The regulation may be based on temperature, staging, or wattage output subject to voltage;

Voltage input is subject to the source while wattage output is subject to current. Automatic is also a term used to describe a preset configuration by installer/factory and/or customer to temperature settings that will be used without manual adjustments to determine operational mode of one or more of the following: gas source then electric source based on that given temperature spread; gas source or electric source based on that given temperature spread; electric source then gas source based on that given temperature spread; electric source or gas source based on that given temperature spread. In an embodiment of the present invention, automatic is an ongoing adjustment that does not need operator regulation and is based on a set of parameters configured by installer/factory and/or customer to adjust temperature, staging, input voltage, or current settings within the device.

The thermostat **230**, regardless of where it is installed, may provide freeze protection to protect piping and mechanical systems using liquid from having the liquid expand at freezing temperatures. Freeze protection may be manually engaged or may automatically engage, for instance once the thermostat registers a certain temperature.

The electric heater element may be controlled either automatically or manually. It may be controlled by varying its input either in current (by varying the amperes) or by varying the voltage (in volts).

While several embodiments of the present invention have been illustrated and described herein, many changes can be made without departing from the spirit and scope of the invention. Accordingly, the scope of the invention is not limited by any disclosed embodiment. Instead, the scope of the invention should be determined from the appended claims that follow.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. An adaptive heating apparatus for heating a recreational vehicle, the adaptive heating apparatus comprising:
- a first heat unit configured to be powered by a first energy source;
- a second heat unit configured to be powered by a second energy source that is different than the first energy source; and
- a forced-air circulation unit,
- wherein the adaptive heating apparatus is operable to:
  - employ the first heat unit during a first heating operation using the first energy source; and
  - employ the second heat unit during a second heating operation using the second energy source,
- wherein the adaptive heating apparatus comprising the first heat unit, the second heat unit, and the forced-air circulation unit, is configured to fit within a confined physical structure of the recreational vehicle, and
- wherein the forced-air circulation unit is configured to circulate air through the first heat unit and the second heat unit during the second heating operation.

2. The adaptive heating apparatus of claim **1**, wherein the first heat unit is a gas furnace component of the adaptive heating apparatus, and the first energy source is a liquefied petroleum gas.

3. The adaptive heating apparatus of claim **1**, wherein the second heat unit is an electric heater component of the adaptive heating apparatus that is positioned adjacent to the first heat unit within the adaptive heating apparatus, and the second energy source is electricity.

4. The adaptive heating apparatus of claim **1**, wherein the forced-air circulation unit is an electric fan.

5. The adaptive heating apparatus of claim **1**, wherein the first energy source is stored in a refillable energy container located at the recreational vehicle, and wherein the second energy source emanates from a shore power source that is peripheral to the recreational vehicle.

6. The adaptive heating apparatus of claim **1**, wherein the first heat unit and the second heat unit are configured to operate based on input received from a thermostat device.

7. A hybrid heating apparatus for heating a mobile residence, the hybrid heating apparatus comprising:
- a first heat unit configured to be powered by a liquefied petroleum gas;
- a second heat unit configured to be powered by electricity; and
- a forced-air circulation unit,
- wherein the hybrid heating apparatus comprising the first heat unit, the second heat unit, and the forced-air circulation unit, is configured to fit within a confined physical structure of the mobile residence, and
- wherein the forced-air circulation unit is configured to circulate heated air from the second heat unit through the first heat unit during an electric heating operation.

8. The hybrid heating apparatus of claim 7, wherein the second heat unit is an electric heater component of the hybrid heating apparatus that is positioned adjacent to the first heat unit within the hybrid heating apparatus, and wherein the first heat unit is a gas furnace component of the hybrid heating apparatus.

9. The hybrid heating apparatus of claim 7, wherein the forced-air circulation unit is an electric fan.

10. The hybrid heating apparatus of claim 7, wherein the liquefied petroleum gas is stored in a refillable container located at the mobile residence, and wherein the electricity emanates from a shore power source that is peripheral to the mobile residence.

11. The hybrid heating apparatus of claim 7, wherein the first heat unit and the second heat unit are configured to operate based on input received from a thermostat device.

12. The adaptive heating apparatus of claim 1, wherein the forced-air circulation unit is configured to circulate air through the first heat unit and the second heat unit during the first heating operation.

13. The adaptive heating apparatus of claim 1, wherein the second heat unit comprises a plurality of heater coils that are configured to enable the adaptive heating apparatus to operate at one of multiple different thermal power outputs during the second heating operation.

14. The hybrid heating apparatus of claim 7, wherein the forced-air circulation unit is configured to circulate heated air from the first heat unit through the hybrid heating apparatus during a gas heating operation.

15. The hybrid heating apparatus of claim 7, wherein the second heat unit comprises a plurality of heater coils that are configured to enable the hybrid heating apparatus to operate at one of multiple different thermal power outputs during the electric heating operation.

16. The hybrid heating apparatus of claim 15, wherein one or more of the plurality of heater coils are coupled at the second heat unit within the hybrid heating apparatus.

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